

NON-PUBLIC?: N
ACCESSION #: 9307200258
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Waterford Steam Electric Station Unit 3 PAGE: 1 OF 10

DOCKET NUMBER: 05000382

TITLE: Reactor Trip Caused By Failure of FWCS Feed Flow Square
Root Extractor
EVENT DATE: 06/15/93 LER #: 93-002-00 REPORT DATE: 07/15/93

OTHER FACILITIES INVOLVED: N/A DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR
SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: D.W. Vinci, Operations TELEPHONE: (504) 464-3178
Superintendent

COMPONENT FAILURE DESCRIPTION:
CAUSE: X SYSTEM: JB COMPONENT: LC MANUFACTURER: D142
REPORTABLE NPRDS: Y

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On June 15, 1993, at 1604 hours, Waterford 3 was operating in Mode 1 at 100% power when the reactor tripped due to a high Steam Generator level caused by the failure of the Feedwater Control System (FWCS).

The root cause of this event was the failure of the square root extractor in the feedwater flow circuit for FWCS #1. The failure caused calculated feedwater flow to drop to zero and generated a high demand signal from FWCS #1 which, in turn, caused the #1 Feedwater Regulating Valve to go fully open and overfeed the #1 steam generator.

Corrective action for this event includes, in part, replacement and analysis of failed components, review of alarm set points (two expected alarms were not received during the event), operator training, and reevaluation of Feedwater Control System troubleshooting practices. This

event posed no risk to the health and safety of the general public or plant personnel. Similar events include LER's 85-041, 87-008, 89-013, and 91-013.

END OF ABSTRACT

Attachment "Required Number of Digits/Characters For Each Block" omitted.

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REPORTABLE OCCURRENCE

On June 15, 1993, at 1604 hours, Waterford 3 was operating in Mode 1 at 100% power when the reactor (EIS Identifier AB) tripped due to a high level in Steam Generator (SG) #1. The high steam generator level was caused by the failure of the Feedwater Control System (FWCS; EIS Identifier JB).

The reactor trip was reported to the NRC via the Emergency Notification System as required by 10CFR50.72(b)(2)(ii). As an unplanned actuation of the Reactor Protection System (RPS; EIS Identifier JC), this event is reportable as an LER in accordance with 10CFR50.73(a)(2)(iv).

INITIAL CONDITIONS

Plant Power 100%

Plant Operating Mode Mode 1; Power Operation

Procedures Being Performed Specific None
to this Event

Technical Specification LCO's in None
Effect Specific to this Event

Major Equipment Out of Service None
Specific to this Event

EVENT SEQUENCE

At approximately 1530 hours on June 15, 1993, an INPO evaluator informed the Control Room staff that Main Feedwater Regulating Valve (MFRV; EIS Identifier JB-FCV) #1 was slowly oscillating over a range of approximately 1 to 1.5 inches. The operators observed the FWCS #1 master controller output oscillating between 60% and 80% and notified I&C Maintenance personnel of the condition.

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Upon arriving in the Control Room, an I&C foreman requested that the Control Room Supervisor (CRS) place the FWCS #1 master controller in manual for troubleshooting purposes. After discussing the troubleshooting process with the I&C Supervisor and noting that SG #1 level and feedwater flow were very steady, the CRS and the I&C foreman agreed that additional data could be obtained from the FWCS cabinet prior to placing the controller in manual.

In the course of checking the #1 FWCS Main Valve Position Signal (MVPS), the signal was seen to increase to 10 V sub DC, indicating that the #1 MFRV was receiving a signal to fully open. The I&C foreman confirmed that the #1 main feedwater regulating valve was fully open and informed the Control Room staff. The operators confirmed the MFRV position and observed one Steam Generator (SG) #1 level indicator rising and the other steady at 66% level. Also, the Steam/Feedwater Flow Signal Deviation annunciator was not in alarm. This alarm is computer driven and annunciates at a preset deviation between the Main Steam flow and the associated feedwater flow. The operators confirmed the rising level in #1 SG, placed the #1 MFRV controller in manual, and started to close the valve when the reactor tripped on high SG level.

When the reactor tripped at 1604 hours, operators performed the immediate actions for a reactor trip in accordance with Emergency Operating Procedure OP-902-000, "Emergency Entry Procedure."

At 1612 hours, operators entered Emergency Operating Procedure (EOP) OP-902-005, "Loss of Offsite Power," due to the loss of one of the four non-safety busses. When the generator tripped following the reactor trip, one of the busses failed to automatically transfer from the Unit Auxiliary Transformer (UAT; EHS Identifier EA) to the Startup Transformer (SUT; EHS Identifier EA) because of a failed fuse in the voltage sensing circuit for the synch check relay. The failed fuse prevented the synch check relay from confirming that

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the output voltage for the associated SUT and the bus were in sync and prevented the automatic bus transfer. The failed fuse was identified just prior to the reactor trip by electricians who were in the process of troubleshooting a related problem. A manual transfer was performed and the bus was re-energized at 1716 hours.

The reactor trip recovery process was complicated somewhat when the #1

Temperature Control Valve (TCV) did not close when the Moisture Separator Reheater (MSR; EIIS Identifier SB) heater controls were reset following the trip, thus creating the potential for excessive reactor cooldown. In accordance with OP-902-000, operators made several (unsuccessful) attempts to remotely close or isolate the TCV. The valve was closed manually by an operator at 1610.

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TIME LINE

TIME EVENT REMARKS CONSEQUENCES

Approx. Metering fuse blows No signal to synch
1400 check relay;
automatic bus
transfer disabled

1500 Control Room Caused by blown Initiate
personnel notice 7KV metering fuse troubleshooting
MW-hour reading low.

1530 Control Room informed Signal swing about Initiate
of MFRV oscillation 20% troubleshooting

-

1540

Approx. CRS opts to maintain No apparent need When control
1550 SG #1 master for immediate system failed,
controller in transfer. MFRV #1 went
automatic fully open

Approx. I&C taking readings MVPS increased to MFRV #1 is fully
1603 on FWCS #1 10 V sub DC open. Control Rm
staff notified

1604 Operator notes Operator questions
conflicting SG #1 level indication/
level indication: delays corrective
red pen rising/ green
pen steady

1604 Operator confirms Delays placement of
rising level in SG #1 master controller to
manual

1604 MFRV #1 controller At this time SG #1 Reactor trip placed in manual and already overfed and close closing valve does not stop level rise

1604 Reactor Trip Tripped on High SG #1 level

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1604 Turbine trip/ Electrical supply With loss of Generator trip to 1 and 2 busses metering fuse, should transfer no voltage sensed from UAT to SUT by synch check relay; 3A1 bus does not transfer

1604 3A1 bus does not Loss of RCPs 1A transfer 2A; loss of Circ Water pumps A & C; loss of Condensate Pumps A&C

MSR TCV #1 does not Can result in close when MSRs reset excessive cooldown

1610 Operators manually Cooldown rate closes TCV #1 stabilized

1716 Energized 3A1 bus Manual transfer

1730 Exit OP-902-005, Exit Emergency enter OP-10-001 Operating procedures, enter normal operations

CAUSAL FACTORS

The root cause of this event was equipment failure, specifically, the intermittent failure of the square root extractor in the feedwater flow circuit for FWCS #1. This caused calculated feedwater flow to drop to zero and generated a high demand signal from FWCS #1. This in turn caused the FWRV #1 to go fully open and overfeed the #1 steam generator. Suspect components were replaced and subjected to further analysis and troubleshooting. The Feedwater Flow Square Root Extractor failed completely during subsequent testing but the actual cause of the failure

was not determined. The modules were sent to the vendor and indications are that a transistor failed in an amplifier in the square root extractor module.

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A number of contributing causes of this event have been identified:

First, equipment anomalies may have caused a delay in the operator's analysis of the situation. The pen for one of the steam generator level indications stuck and required the operator to confirm the rising steam generator level by checking redundant indications. Also, two alarms, the #1 SG Steam/Feedwater Flow Signal Deviation alarm and the #1 SG Level HI/LO alarm did not annunciate.

In hindsight, more timely manual operator action may have mitigated the event. Sufficient indication was available to justify placing the #1 FWRV master controller in manual immediately upon noticing that the valve was fully open.

Finally, equipment failure resulted in the failure of one of the non-safety busses to transfer from the Unit Auxiliary to the Startup transformer. The failed fuse in the metering circuit for bus AI voltage removed the voltage signal to the sync check relay and prevented the automatic bus transfer.

NON-CAUSAL FACTORS

The failure of the TCV #1 to close was identified as a non-causal factor. The cause of this failure has not been determined.

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ACTIONS TO PREVENT RECURRENCE

To address the root cause, failed components in the FWCS were replaced and sent to the vendor for analysis. Because the vendor's analysis identified a failed transistor in the square root extractor module, Waterford 3 will evaluate the need for periodic replacement of these modules in the FWCS and the Steam Bypass Control System.

Second, Feedwater Control System troubleshooting practices will be reevaluated in light of this event. Specifically, it may be appropriate to place the Main Feedwater controllers in manual prior to manipulating the Feedwater Control System digital displays for troubleshooting purposes.

Waterford 3 will take a number of actions to address the contributing causes of this event:

1. With regard to control room indications, the SG #1 level indications have been repaired. Neither the Steam/Feedwater flow deviation alarm nor the high steam generator level alarms annunciated as expected during this event, possibly as a result of less than optimal set points. These conditions will be examined and corrective actions taken as appropriate.
2. The performance of the Steam/Feedwater flow deviation alarm in the Waterford 3 Control Room simulator will be validated against actual plant performance.
3. This event will be reviewed with all Operations Department personnel. The review will emphasize philosophy and decision making concerning when direct observation of control board parameters is appropriate, when controllers should be placed in manual, and finally, when the reactor should be manually tripped.

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4. Waterford 3 will review and update the FWCS lesson plan to insure that the plan includes appropriate detail regarding interfaces between Process Analog Control (PAC), the FWCS, the Plant Monitoring Computer, and control board indications.
5. The failed metering fuse was sent to the vendor for analysis. Waterford 3 will take appropriate corrective action pending the results of the analysis.

The corrective actions described above will be complete by November 17, 1993.

Finally, the cause of the problem with the TCV #1 valve will be investigated and corrective action taken as appropriate.

SAFETY SIGNIFICANCE

Because the Reactor Protection System generated a reactor trip as required for the high steam generator level condition, this event posed no risk to the health and safety of the general public or plant personnel.

SIMILAR OCCURRENCES

LER 85-041 reported a reactor trip that occurred due to low level in Steam Generator #2. The level deviation was caused by the failure of the steam flow square root extractor in FWCS #2. The cause of the square root extractor failure could not be determined and the module was replaced. LER 87-008 reported a reactor trip that occurred due to a high level in SG #1. Although troubleshooting did not conclusively identify the cause of the trip, the feedwater flow square root extractor was replaced to eliminate one possible cause of the FWCS failure. Subsequent testing of the suspect square root extractor did not identify any problems.

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LER's 89-013 and 91-013 reported reactor trips that occurred as a result of steam generator level abnormalities. Failed PAC cards in the FWCS caused both trips.

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Entergy Entergy Operations, Inc
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Tel 504-464-3120

D. F. Packer
General Manager
Plant Operations
Waterford 3

W3F1-93-0164
A4.05
PR

July 15, 1993

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Subject: Waterford 3 SES
Docket No. 50-382
License No. NPF-38
Reporting of Licensee Event Report

Gentlemen:

Attached is Licensee Event Report Number LER-93-002-00 for Waterford Steam Electric Station Unit 3. This Licensee Event Report is submitted in accordance with the requirements of 10CFR50.73(a)(2)(iv).

Very truly yours,

D.F. Packer
General Manager
Plant Operations

DFP/TWG/ssf
Attachment

cc: J.L. Milhoan, NRC Region IV
G.L. Florreich
J.T. Wheelock - INPO Records Center
R.B. McGehee
N.S. Reynolds
NRC Resident Inspectors Office
Administrator - LRPD

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